BULLETIN

OF THE INSTITUTE OF METALS

VOLUME 5 APRIL 1961 PART 20

INSTITUTE NEWS

Award of Institute Medals

The Council of The Institute of Metals announces the following awards of medals for 1961:

The Institute of Metals (Platinum) Medal to Major C. J. P. BALL, D.S.O., M.C., F.R.Ae.S., F.Inst.Met., Chairman, Magnesium Elektron, Ltd., in recognition of his outstanding services to the non-ferrous metal industries and, in particular, to the magnesium industry.

The Rosenhain Medal to Dr. P. B. HIRSCH, of the Cavendish Laboratory, Cambridge, in recognition of his outstanding contributions in the fields of physical metallurgy and metal physics.

The W. H. A. Robertson Medal for 1960 and Premium of Fifty Guineas to Mr. Y. Yokote and Mr. S. Nomura (Shibaura United Engineering Co., Ltd., Tokyo) for a paper on: "Rolling Aluminium Foil: An Experimental Study on a Modern Mill" (*J. Inst. Metals*, 1959-60, **88**, 241).

Major C. J. P. Ball, D.S.O., M.C.

(Institute of Metals (Platinum) Medallist 1961)

Charles James Prior Ball, son of G. W. Ball, J.P., of Cowes, Isle of Wight, was born on 15 February, 1893. He was educated at Charterhouse and the University of London. During the First World War he was commissioned in the Royal Artillery in 1914, took part in the landing at Cape Helles, Gallipoli, on 25 April, 1915, with the incomparable 29th Division, and served throughout those operations and afterwards in Sinai, France, and Belgium. During those campaigns he was thrice mentioned in despatches and awarded the Military Cross, and later the Distinguished Service Order.

In 1923 he retired from the Army and, following his return to the United Kingdom, joined the firm of F. A. Hughes and Co., Ltd., then a small and struggling concern trading mainly with the Continent in special chemical products. F. A. Hughes & Co., Ltd., with Major Ball as the moving spirit, pioneered in Britain the first real usage of the important light magnesium alloys developed by the Germans. Major Ball decided that, because of the vital importance of magnesium to the rearmament programme, Great Britain could not afford to be dependent on manufacturers abroad for these metals. He took the initiative in the formation of Magnesium Elektron, Ltd., and, as its Chairman and Managing Director, was responsible for the erection of a factory at Clifton Junction, near Manchester, the first unit of which went into production towards the end of 1936, and the second unit some eighteen months later. With the outbreak of war in 1939, the demand for magnesium went up by leaps and bounds, and the plant at Clifton Junction was doubled in 1940. Later, it became clear that still greater production would be needed, and in 1942 Magnesium Elektron, Ltd., on behalf of His Majesty's Government, erected a factory near Burnley of rather larger capacity than the enlarged Clifton Junction plant, both of which operated entirely on indigenous raw materials.

After the entry into the war of the United States in December 1941, the demand for magnesium by the Allied Forces increased so enormously that there was little possibility of its ever being met by available production. Following representations to the British Government in 1941, Major Ball, with two of his staff, flew to the United States to advise the U.S. Government on the problem of how to increase production rapidly. The U.S. Government asked Magnesium Elektron, Ltd., to provide plans and to find and train personnel to erect and operate the largest magnesium plant in the world near Boulder Dam in the Nevada Desert. Not only a factory, but practically a whole town had to be built; houses for the workers, shops, schools, and recreational facilities had all to be provided. This town continues to thrive under the name of Henderson and has become the third largest in Nevada. Under the direction of Major Ball and his technical staff, work was driven ahead at a remarkable pace, and within ten months from breaking ground the first metal was produced, the plant in full production giving 10% more than planned figures.

After the war the demand for magnesium fell back to the pre-war level and the primary side of the industry was faced with the gravest problems, not the least being the huge stocks of virgin and scrap magnesium left in the hands of the Government. Major Ball's faith in the future of magnesium never faltered, and such was his confidence that he negotiated the purchase by his Company of much of the Government stockpile. During these difficult days the last of the U.K. extraction plants was closed down.

Before the war the intense grain-refining effect of zirconium on magnesium had been known, but no method had been evolved which enabled usable alloys to be made. Since the early days, Major Ball had realized the benefits which would result if the problem could be solved and had insisted that development work should be carried on even during the war years. After the war, in spite of the uncertain outlook for magnesium, he continued to support this research, and success came at a time when aircraft designers were in desperate need of strong light alloys capable of operating at elevated temperatures. The development of these zirconium alloys allowed full advantage to be taken of the effects of rare-earth metals in promoting resistance to creep at high temperatures. These alloys proved of immediate value to the designers, since when their use in engines and frames has continued to expand. Improved creep-resisting alloys were later developed by using thorium instead of rare-earth metals. The whole family of zirconium-containing magnesium alloys proved of such value to the aircraft industry that many companies in western countries obtained licences to use the alloys and the processes involved. As a result of these developments Magnesium Elektron, Ltd., now holds a unique international reputation in the magnesium industry.

The value of the efforts of Major Ball have many times been recognized, most recently by the American Magnesium Association. It is no disrespect to him to say that he is now recognized as the " father " of the magnesium industry.

Dr. P. B. Hirsch

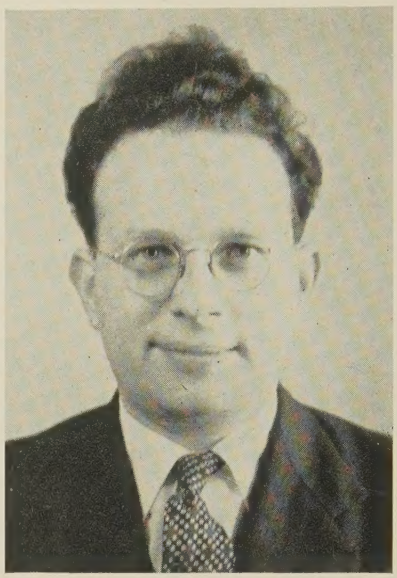
(Rosenhain Medallist 1961)

Peter Bernhard Hirsch was born in 1925 and educated at Sloane School, Chelsea, and St. Catharine's College, Cambridge. He graduated in 1946 and since then has been engaged in research and teaching at Cambridge. He was elected a Fellow of Christ's College in 1960.

Dr. Hirsch started his research career in the Cavendish Laboratory in 1946, when, in collaboration with the late Mr. J. N. Kellar, he developed an X-ray microbeam technique to study the fine structure of cold-worked metals. The subsequent investigations on a variety of metals showed that the fragmentation of the individual grains to form sub-grains was a common feature of plastic deformation. These X-ray studies led to valuable information on the distribution of dislocations in the cold-worked state, and also threw light on the phenomena of recovery and recrystallization.

In 1954, realizing that the newly developed high-resolution electron microscope might be applied to a study of deformed metals, Dr. Hirsch initiated work on the examination of metal foils, so thin that they were transparent to the electron beam. This work quickly confirmed many of the results obtained with the X-ray micro-beam method concerning the formation of sub-grains. However, the most important and impressive observations were those which directly revealed the existence of dislocations, both in annealed and in deformed metals. Dr. Hirsch and his colleagues were able not only to observe individual dislocations in the foils, but also to study their movement and their interactions with each other. The striking electron micrographs made on aluminium and stainless steel are now widely known and represent a landmark in the development of physical metallurgy.

By the careful interpretation of numerous observations, Dr. Hirsch showed that dislocations possessed many of the properties which had been predicted theoretically, as well as some new features of considerable interest. The scope of the work



was extended to include metals deformed in various ways, e.g. at elevated temperatures and by fatigue, and also the defects introduced by quenching from high temperatures. At the same time Dr. Hirsch was not content to accept the pictures of dislocations at their face value, but initiated work designed to interpret the various diffraction effects which were apparent in the electron micrographs. Consequently, many people who now use thin-film electron microscopy have reason to be very grateful to Dr. Hirsch and his colleagues for their penetrating analysis of the various phenomena observed.

In recent years, Dr. Hirsch has also taken a considerable interest in the basic mechanical properties of metals, and by analysis of results on the temperature-dependence of stress/strain curves of single-crystal and polycrystalline pure metals, he has made a substantial contribution to the theory of work-hardening. In addition, he has helped to stress the importance of stacking faults in close-packed metal structures. He has also made a close study of the stacking-fault energies of metals and how they are influenced by alloying.

Death

The Editor regrets to announce the death of:

Sir Arthur Smout, J.P., Chairman of Murex, Ltd., on 21 February, aged 72. He was a Past-President and Fellow of the Institute. The Senior Vice-President (Professor H. O'Neill) represented the Institute at the funeral service held at Church Lench, near Evesham, on 25 February.

Symposium on " Structural Processes in Creep ", 3 and 4 May 1961

The Iron and Steel Institute and The Institute of Metals are holding a joint Symposium on " Structural Processes in Creep " at the Hoare Memorial Hall, Church House, Great Smith Street, London S.W.1, on Wednesday and Thursday, 3 and 4 May 1961. Participation in the Symposium is open to Members of the two Institutes and their guests.

The organization of the meeting, the programme of which is given below, is in the hands of The Iron and Steel Institute. Those wishing to attend are requested to complete the Registration Form (a copy of which will be sent to all members) and return it as soon as possible (and by *not later than Friday, 21 April 1961*) to: The Secretary, The Iron and Steel Institute, 4 Grosvenor Gardens, London S.W.1.

A badge bearing his name will be sent to everyone who registers for the Symposium. Participants are asked to wear these badges at all times during the meeting.

A list of those registered for the Symposium will be distributed to all participants at the first session.

A bound volume of the proceedings of the Symposium will be published in due course; it will contain all the papers presented, together with a full report of the discussions. The volume will be supplied at £3 5*s.* 0*d.* per copy, post free, to all those who apply for it in advance of the Symposium; this should be done by completing the Order for Proceedings and returning it before the meeting to The Iron and Steel Institute.

One set of preprints of the papers will be sent free before the Symposium to all those whose order for the bound volume of proceedings is received at the Institute by 1 May 1961. Preprints of papers will *not* be available separately.

PROGRAMME

Wednesday, 3 May

2.30–5.00 Presentation and discussion of the following papers:

" Intercrystalline Creep Fractures ", by A. H. COTTRELL (*Cambridge University*)

" The Stress-Sensitivity of Creep ", by D. McLEAN and K. F. HALL (*National Physical Laboratory*)

" An Interpretation of the Relationship Between Creep and Fracture ", by P. W. DAVIES and B. WILSHIRE (*University College, Swansea*)

" The Shear Properties of Grain Boundaries in Copper ", by S. HARPER (*British Non-Ferrous Metals Research Association*)

" Grain-Boundary Serrations Developed during Creep ", by A. W. MULLENDORE and N. J. GRANT (*Massachusetts Institute of Technology*)

Thursday, 4 May

10.00–12.30 Presentation and discussion of the following papers:

" The Alloying Behaviour of an Austenitic Base Containing 20% Ni, 20% Cr, and 20% Co ", by H. C. CHILD (*Jessop-Saville, Ltd.*)

" Relationships Between the Structure and Creep Properties of Ni–Cr-Base Alloys ", by D. W. WAKEMAN (*Mond Nickel Co., Ltd.*)

" Metallographic Features of Creep-Resistant Alloys ", by J. NUTTING (*Leeds University*) and J. M. ARROWSMITH (*Cambridge University*)

" The Effect of Structure on the Creep-Resistance of Titanium Alloys ", by A. L. DALTON (*Jessop-Saville, Ltd.*), D. WEBSTER (*Aeon Laboratories*), and H. C. CHILD (*Jessop-Saville, Ltd.*)

2.30–5.00 Presentation and discussion of the following papers:

" An Investigation of the Creep Ductility of 18–12–1Nb and Related Steels ", by H. W. KIRKBY and R. J. TRUMAN (*Thos. Firth and John Brown, Ltd.*)

" Some Causes of Variation in High-Temperature Strength of Steels, with Particular Reference to the Silicon Content ", by J. GLEN, J. LESSELLS, R. R. BARR, and G. LIGHTBODY (*Colvilles, Ltd.*)

" Structural Aspects of Creep-Resisting Steel ", by K. J. IRVINE, J. D. MURRAY, and F. B. PICKERING (*United Steel Companies, Ltd.*)

" Some Factors Affecting the Creep-Rupture Performance of a 3% Cr–Mo–W–V Steel at 550° C ", by J. D. HODKIN, L. G. FINCH, and E. W. COLBECK (*Hadfields, Ltd.*)

" The Variability of the Creep-Resistance of Mild Steel ", by N. P. ALLEN and L. M. T. HOPKIN (*National Physical Laboratory*)

" The Structure and Properties of 1% Cr–0·5% Mo Steel after Service in CEGB Power Stations ", by L. H. TOFT and RUTH A. MARSDEN (*Central Electricity Research Laboratories*)

Election of Members

The following 6 Ordinary Members and 4 Student Members were elected on 14 January 1961:

As Ordinary Members

KAUFMAN, Murray, B.M.E., M.S., Ph.D., Engineer, Materials and Process Development, Small Aircraft Engine Department, General Electric Co., West Lynn, Mass., U.S.A.

KING, Thomas John, Senior Metallurgist in charge of Extrusion Development, High Duty Alloys, Ltd., Winscales.

MIKOL, Robert C., B.S., Senior Metallurgist, Ormet Corp., Hannibal, Ohio, U.S.A.

MURAKAMI, *Professor* Yotaro, D.Eng., Professor, Department of Metallurgy, Kyoto University, Kyoto, Japan.

WINTERHAGER, *Professor* Helmut, Dr.-Ing., Head of the Department and Professor of Non-Ferrous Metallurgy, Institut für Metallhüttenwesen und Elektrometallurgie, Rheinisch-Westfälische Technische Hochschule, Aachen, Germany.

WRIGHT, William Patrick, Scientific Apparatus Department, Associated Electrical Industries, Ltd., Manchester.

As Student Members

ROYCHOUDHURY, Nikhil, B.Sc., Student, Rheinisch-Westfälische Technische Hochschule, Aachen, Germany.

SMITH, David Granville, Technical Staff Trainee, Central Electricity Generating Board, Southern Division, Portsmouth.

TEBBY, Michael Robert, Undergraduate, Department of Metallurgy, King's College, Newcastle-on-Tyne.

THOMSON, Robert, B.Sc., A.R.C.S.T., L.I.M., Metallurgist, Babcock and Wilcox, Ltd., Renfrew.

The following 8 Ordinary Members, 3 Junior Members, and 4 Student Members were elected on 21 February 1961:

As Ordinary Members

A'BRASSARD, Herbert Forbes, Managing Director, Elm Engineering, Ltd., Aylesbury.

GROUT, Joseph William, Works Manager, Western Copper Mines, Ltd., New Westminster, B.C., Canada.

HARRISS, Noel Richard Henry, M.A., A.M.S.A.I.Mech.E., Managing Director, R. H. Harriss (Pty.) Ltd., Johannesburg, Transvaal, South Africa.

LEAR, Edward Herbert, Works Metallurgist, Evered and Co., Ltd., Smethwick.

LUMB, Robert, L.I.M., Assistant to Works Metallurgist, Monk Bridge Iron and Steel Co., Ltd., Leeds.

SCHOLEFIELD, Harry Houchen, Ph.D., B.Sc., F.Inst.P., F.I.M., Technical Director, Telcon Metals, Ltd., Crawley.

TAKEYAMA, Taro, B.Eng., Metals Research Laboratory, Faculty of Engineering, Hokkaido University, Hokkaido, Japan.

WALPOLE, Kenneth William, B.Eng., Materials and Processs Controller, Pyrotenax, Ltd., Hebburn-on-Tyne.

As Junior Members

DAS, Anil Kumar, B.M.E., Graduate Apprentice, Hindustan Steel, Ltd., Durgapur, Bengal, India.

HEISER, Francis Alvin, B.S.Met.E., Metallurgist, Watervliet Arsenal, Watervliet, N.Y., U.S.A.

WADE, Cedric Arthur, B.Sc., Metallurgist, Metal Manufactures, Port Kembla, N.S.W., Australia.

As Student Members

FARAG, Mahmoud Mohamed, B.Sc., Post-Graduate Student, Department of Metallurgy, University of Sheffield.

JEWETT, Robert P., M.S., Student, Department of Mining and Metallurgy, University of Wisconsin, Madison, Wis., U.S.A.

LOCKINGTON, Gerald William, Undergraduate, Department of Metallurgy, University of Birmingham.

REYNOLDS, Richard Alan, B.Sc., Research Student, Department of Metallurgy, University of Sheffield.

NEW OFFICERS

Below are given biographical details of members who took office as Vice-Presidents and Members of Council at the Annual General Meeting on 21 March.

Mr. W. F. Randall

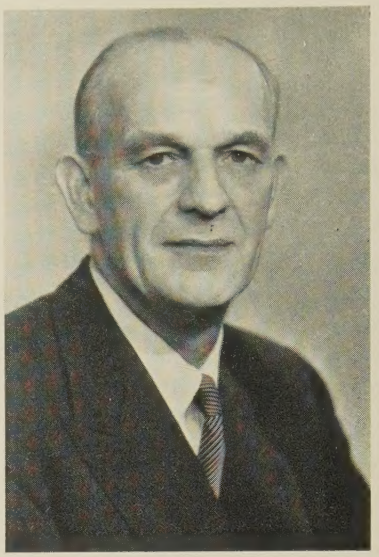
(Vice-President)

Walter Frederick Randall was educated at Rutlish School, Merton, and the Royal School of Mines, where he obtained the A.R.S.M. and the B.Sc. degree of London University.

In 1922 he joined the Telegraph Construction and Maintenance Co., Ltd., as Research Metallurgist. In 1946 he was elected to the Board of the Company, becoming Deputy Chairman in 1959.

With the establishment of Telcon Metals, Ltd., as a separate company in 1960, Mr. Randall was appointed Deputy Chairman and Managing Director of the new company, and continued as Chairman of the subsidiaries of the Group. Telcon Metals, Ltd., is engaged in the production and fabrication of specialized alloys for the electrical and instrument-making industries.

Mr. Randall has been a Member of the Institute since 1922, and has served on the Council since 1958. He is also a

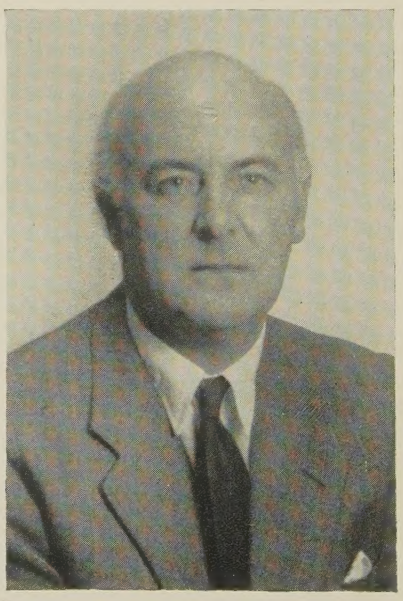


Member of the Iron and Steel Institute, a Fellow of the Institution of Metallurgists, a Member of the Institution of Electrical Engineers, a Fellow of the Royal Society of Arts, and a Member of the British Institute of Management.

The Earl of Verulam

(Vice-President)

Lord Verulam was born in 1912 and educated at Oundle and Christ Church, Oxford. In 1936 he joined Enfield Zinc Products, Ltd., and in 1938 Enfield Rolling Mills, Ltd., of which company he is now Chairman and Managing Director.



During the last war he served as a pilot in Coastal Command. From 1943 to 1945, and again from 1950 to 1959, he represented the St. Albans division of Hertfordshire in Parliament.

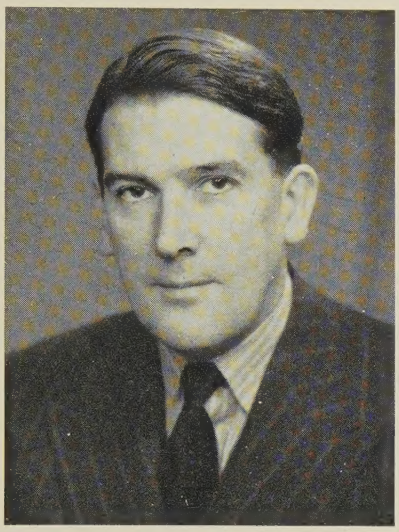
Lord Verulam has been a member of the Executive of the

British Non-Ferrous Metals Federation since 1950 and was President in 1957–59. He served as an Ordinary Member of Council of the Institute from 1953 to 1957 and as a Vice-President from 1957 to 1960.

Mr. N. I. Bond-Williams

(Member of Council)

Mr. Noel Ignace Bond-Williams was born in 1914 and educated at West House School and Oundle. He entered Birmingham University in 1932 and studied metallurgy under



Professor Hanson, obtaining his B.Sc. degree with Honours in 1935. For a period he carried out research at the University, but abandoned it in 1937 on the death of his father, Mr. W. H. Williams, whom he succeeded as Managing Director of the Aston Chain and Hook Co., Ltd., Birmingham. He is also a Director of Enfield Rolling Mills, Ltd., Barker and Allen, Ltd., and W. E. Martin, Ltd.

Mr. Bond-Williams was President of the Guild of Undergraduates of Birmingham University in 1936–37, and President of the Guild of Graduates in 1947–50. He is a member of the American Society for Metals and of the American Institute of Mining and Metallurgical Engineers, and a Fellow of the Institution of Metallurgists. He also serves on the Council of the Industrial Welfare Society. He previously served on the Institute's Council from 1951 to 1955.

Professor A. H. Cottrell

(Member of Council)

Alan Howard Cottrell was born in 1919 and educated at Moseley Grammar School and the University of Birmingham. Here he gained the B.Sc. degree, with First Class Honours in Metallurgy, in 1939 and the Ph.D. in 1942.

From 1939 to 1945 he was engaged on research, mainly in connection with the welding of tank armour. He was appointed a Lecturer in Metallurgy at Birmingham in 1943, and he subsequently assisted the late Professor Hanson in planning a School of Physical and Theoretical Metallurgy. In 1949 he was appointed to the position of Professor of Physical Metallurgy.

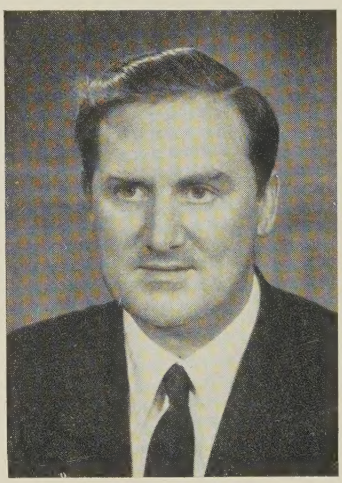
Professor Cottrell left Birmingham in 1955 to become Deputy Head of the Metallurgy Division of the Atomic Energy Research Establishment, Harwell. Here he worked mainly on problems connected with uranium fuel elements, Wigner energy in graphite, radiation embrittlement of steel, and radiation damage in general.

In 1958 Professor Cottrell was appointed to the Goldsmiths' Chair of Metallurgy in the University of Cambridge and in the same year was awarded the Cambridge M.A. degree.

Since 1945 Professor Cottrell's researches have been mainly concerned with the plasticity, strength, fracture, and irradiation behaviour of metals, subjects to which he has made important contributions in papers published in the Institute's *Journal* and elsewhere. He has also lectured extensively. He has made several lecture tours in the United States, the U.S.S.R., and other countries. He delivered the Institute of Metals Lecture of the A.I.M.E. in 1958 and the Thomas Hawksley Lecture of the Institution of Mechanical Engineers in 1959.

Professor Cottrell was elected a Fellow of the Royal Society in 1955; more recently he was elected Foreign Fellow of the Royal Swedish Academy of Sciences, Foreign Honorary Member of the American Academy of Arts and Sciences, Fellow of Christ's College, Cambridge, and Liveryman of The Goldsmiths' Company. He is also a Fellow of the Institution of Metallurgists and a member of the Iron and Steel Institute.

Professor Cottrell is a member of the Inter-Service Metallurgical Research Council and Chairman of its Basic Properties of Metals Committee. He is also a member of the Research Council of D.S.I.R., Chairman of the D.S.I.R. Low-Temperature and Solid-State Committee, D.S.I.R. Visitor to



the British Non-Ferrous Metals Research Association, Member of the Electric Supply Research Council, and Member of the Iron and Steel Board Technical Advisory Panel. He has been also Associate Editor for Great Britain of *Acta Metallurgica*, and he is the author of two books: "Theoretical Structural Metallurgy" (1948) and "Dislocations and Plastic Flow in Crystals" (1953).

He became a member of the Institute in 1938, and has served on its Publication Committee and is a member of its Metal Physics Committee. He was awarded the Rosenhain Medal in 1954.

Mr. G. A. Rider

(Member of Council)

Guy Alfred Rider was born in Birmingham in 1901 and educated at Waverley Road Secondary School. On leaving school in 1917 he joined Birmingham Aluminium Casting

(1903) Co., Ltd., and served the Company in a number of capacities before being appointed Commercial Manager in 1942. He became a Director of the Company in 1947 and was appointed to the Board of the Parent Company, Birmid Industries, Ltd., in 1955. Last year he became Deputy Managing Director of Birmid Industries, Ltd. He is also on the Boards of a number of the Group Companies, including Birmetals, Ltd.

Mr. Rider is a Fellow of the Institute of Cost and Works Accountants, Vice-Chairman of the Light Metal Founders' Association, Member of the Aluminium Industry Council and Member of the Magnesium Industry Council.

PERSONAL NOTES

Mr. E. Anderson has left Oxford and is now at the Battelle Memorial Institute, Geneva.

Mr. T. N. Baker has left the English Electric Co., Ltd., and is now at the Tube Investments Research Laboratories, Hinxton Hall.

Mr. W. E. Ballard has retired as Managing Director of Metallisation Ltd., Dudley, but remains on the Board of the Company.

Dr. W. Boas, Chief of the Tribophysics Division of the C.S.I.R.O., Melbourne, has been awarded the Silver Medal of the Australian Institute of Metals.

Dr. C. J. L. Booker has left Cambridge to take up a Research Fellowship with the National Research Council in Ottawa.

Dr. B. Cina is now with the Nuclear Materials and Equipment Corp., Apollo, Pa.

Mr. H. P. Croft is now associated with Copper Range Company, Boston, Mass., in the capacity of Vice-President, Research.

Dr. J. E. Harris has left Sheffield University and is now at the Berkeley Nuclear Laboratories of the Central Electricity Generating Board.

Dr. J. T. Jazwinski has been elected to full membership of the Pennsylvania Academy of Sciences.

Mr. R. B. Jones has left Sheffield University and is now at the Berkeley Nuclear Laboratories of the Central Electricity Generating Board.

Mr. J. R. Linford is now with Castolin Schweissmaterial AG, Lausanne, Switzerland.

Mr. P. R. Marchant has left Johnson, Matthey and Co., Ltd., to take up an appointment with the Copper Development Association.

Mr. G. W. Parry has left Hudson Bay Mining and Smelting Co., to take up an appointment in the Metallurgy Division of Atomic Energy of Canada, Ltd., Chalk River, Ont.

Mr. L. A. Phelps is now Senior Research Metallurgist at the B.S.A. Group Research Centre, Birmingham.

Dr. W. A. Rachinger has left the Aeronautical Research Laboratories to take up an appointment as Senior Lecturer in Physics at Monash University, Melbourne.

Mr. A. Rozner has been awarded the Ph.D. degree of the University of Notre Dame and has taken a post in the Engineering Research Laboratory of E.I. du Pont de Nemours and Co., Wilmington, Delaware.

Mr. W. W. Sneary has left the British Non-Ferrous Metals Research Association to take up an appointment with Acton Bolt, Ltd., London.

Dr. J. F. Thompson, Honorary Chairman of the International Nickel Company of Canada, Ltd., has been elected an Honorary Member of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

Dr. P. W. Whitton, Professor of Mechanical Engineering in the University College of the West Indies, Trinidad, has been appointed the first Dean of the Faculty of Engineering in the College.

Dr. F. N. Zein is now at the Department of Physical Metallurgy, Imperial College, London.

OBITUARY

Herr L. J. Nedorostek

Leopold Johann Nedorostek, director of the Schafsbrücke Works of the Busch-Jaeger Dürener Metallwerke AG at Lüdenscheid, died suddenly on 3 December 1960 at the age of 60.

Born in 1900 at Birkenau, near Auschwitz, and educated at a college at Bielitz, Herr Nedorostek joined the staff of the rolling mills at Dzeiditz as a shift assistant in 1919 and subsequently rose to the position of deputy manager. From 1926 to 1939 he was manager of the Chaduar-Metallwerke at Bodenbach/Sudetengau. He took over the management of the Schafsbrücke Works of Busch-Jaeger Dürener Metalwerke AG in February 1941, and retained the position until his death.

Herr Nedorostek had a remarkably wide knowledge of metallurgy and devoted much of his time to the exchange of information in the field of metalworking with many specialists in universities and industry. As a result of these activities he had a large circle of friends who valued him not only as an outstanding expert but also for his human qualities and his personal advice.

LETTER TO THE EDITOR

What Should the Institute Publish ?

Whilst I am in agreement with the spirit that has prompted the letters of Mr. Bailey and Professor Cottrell, I feel that neither has pointed to the fundamental difficulty of attracting practical papers of comparable standing to the more academic contributions and to the danger in publishing the second rate. The research worker achieves his reputation and status in the profession by his publications. Other things being equal, the higher the standing of the publishing body the higher is the author's reputation. The practical metallurgist, on the other hand, gains his reputation and advancement by the technical and commercial efficiency of his management. There is rarely an incentive, and frequently a disincentive, for him to publish. It is only when a prestige or advertising motive outweighs the disadvantage of giving away confidential information that the employers of the practical man encourage publication. That is the main reason why manufacturers of metallurgical plant are often the most fruitful source of practical papers. I am all in favour of maintaining the family unity, but the " executives, businessmen, salesmen, operators, plant metallurgists, and engineers " (to re-quote Mehl) cannot and will not produce papers in the same quantity and of the same quality as the scientists.

By all means let us work to keep both the research and practical man in contact and alive to each other's interests, but there are other and better means of making the research metallurgist aware of practice than by publishing papers.

A works visit will teach much more than any paper. Symposia are excellent for getting everyone together to discuss both the practical application of scientific research and the ways in which the research man can most profitably seek to assist the practice of metallurgy; but the success of such symposia is not always in direct proportion to the number and length of the papers presented and published in the *Journal*. Local Section meetings are excellent for getting all types together. In fact, the less formal the occasions the better for real contact and this applies to " scientific " as well as " practical " gatherings. At its best the *Journal* is a medium by which knowledge is built up step by step. Almost every issue contains references to original work going back for more than 25 years. It is a matter for regret that so many papers of first importance to scientific metallurgy are now being published in *Phil. Mag.* or *Acta Met.*, rather than the *Journal*. The dilution of scientific papers with more popular practical articles must increase this regrettable tendency.

E. A. G. Liddiard

Fulmer Research Institute,
Stoke Poges, Bucks.

LECTURES TO LOCAL SECTIONS AND ASSOCIATED SOCIETIES

The Development of Some New Bearing Materials

A lecture on " The Development of Some New Bearing Materials " was given by Mr. P. G. Forrester (The Glacier Metal Co., Ltd.) to the London Local Section on 2 February.

He said that the development of internal-combustion engines with increased power output for a given capacity had resulted in a progressive increase in the loads and temperatures to which main and big-end bearings were subjected, necessitating the replacement of white metal by stronger materials. Copper–lead-lined bearings had about twice the fatigue strength of white metal, but they caused increased bearing and journal wear and were subject to corrosion. These defects could be partially overcome by the use of electrodeposited lead–tin or lead–indium overlays, though thin overlays tended to wear off, and thick overlays were liable to failure by fatigue and/or cavitation.

Of the common metals intermediate in strength and melting point between lead and copper, only aluminium appeared to offer much promise as a bearing material. Aluminium itself had poor seizure-resistance, but this could be greatly improved by adding about 20% tin. As-cast alloys with 20% tin were weak and brittle owing to intercrystalline films of tin, but the mechanical properties could be much improved by cold-working and annealing, which caused the intercrystalline tin to break up. Reticular tin–aluminium alloys so made were ductile and could be bonded to steel by rolling, to form bimetal strip from which bearings were pressed. Such bearings had about 2½ times the fatigue strength of white metal, while giving rise to little, if any, more wear. Many millions of such bearings were now in use.

A second recent development in bearing materials was the polytetrafluoroethylene-impregnated bronze dry bearing, which operated without any form of lubrication. P.T.F.E. itself was an extremely inert and stable material, but its poor mechanical properties and low thermal conductivity severely limited its usefulness as a bearing material. A metal matrix provided strength and thermal conductivity, and tin bronze had proved a particularly suitable matrix, for reasons not fully established. The latest form of this material embodied also fine lead powder, which was mixed with the P.T.F.E. before impregnation. This gave a further threefold improvement in performance, allowing, for example, 1000 hours' life at a *PV* (load × speed) condition of 16,000 ($lb/in^2 \times ft/min$). This P.T.F.E./lead/bronze combination was either bonded to steel and pressed into bushes, &c. (Glacier DU), or alternatively made by impregnation of porous bronze compacts (Polyslip 1M). These materials were used particularly where lubrication by oil or grease was a nuisance (textiles, etc.), inconvenient to apply, ineffective owing to high loads, or impracticable owing to extremes of temperature.

Some Recent Developments in the Welding of Metals

At the meeting of the Leeds Metallurgical Society on 4 January, Mr. E. N. Gregory (British Welding Research Association) gave a lecture entitled " Some Recent Developments in the Welding of Metals ".

He said that in the gas-shielded metal-arc welding of steel argon was expensive, but the use of cheaper carbon dioxide had the disadvantages that very high currents were necessary to obtain spray-type metal transfer suitable for welding, and positional welding was not possible.

Dip transfer, which could be used at low currents, was a recent development in which the tip of the filler wires dipped into the pool of molten metal and the consequent short circuit caused an increase in welding current that heated the electrode tip so that it melted off and an arc was re-established. This was repeated 50–200 times per second. Special power

sources were necessary for the " dip transfer " process, which could be used for all positional welding of steel and, in conjunction with fine wires, could be used for very thin sheet in mild steel, stainless steels, and aluminium.

A short film taken with a high-speed camera showed dip transfer in slow motion.

Electro-slag welding, invented in Russia, was a fully automatic process for making vertical welds in thick plate. In principle it was a form of continuous casting, the heat necessary to melt the filler wire being provided by the resistance heating of an electrically conductive molten slag. Water-cooled copper shoes acted as dams to contain the molten metal and slag bath and moved up the seam as welding proceeded.

In capacitor-discharge welding the spark made by discharging a capacitor was used for welding wires together or to flat surfaces. Wires could be butt welded or welded in V-shape to produce thermocouples, and thin sheet could be spot welded by this method.

In percussion welding a capacitative circuit charged to a high potential was discharged across the gap between parts as they approached each other under a propelling force. An arc produced for 0·001 sec melted a shallow surface layer, and the parts were brought percussively together to make a weld.

Electron-beam welding utilized the kinetic energy of electrons in a vacuum to melt the metals being welded. Many materials, such as reactive and recently developed metals and dissimilar metals, could be joined in thicknesses up to $\frac{1}{4}$ in., and with special techniques even thicker sections could be joined.

In friction welding the cylindrical parts to be welded were mounted in chucks on the same horizontal axis. One part rotated in contact with the other, which was held stationary. In a few seconds sufficient heat was generated for welding to take place when relative motion stopped and increased pressure was applied. The energy consumed might be only 10% of that required for a similar flash-butt weld. The process had been used for welding shanks to twist drills, gears to spindles (down to watch sizes), studs to sheet, and pipes in metals including steel, copper, aluminium, and cast iron.

Oxford Local Section Junior Members' Evening

At the Junior Members' Evening arranged by the Oxford Local Section on 29 November 1960, three short lectures were given by Dr. V. D. Scott (Atomic Weapons Research Establishment), Mr. N. Swindells (A.E.I. Research Laboratory), and Mr. D. B. Gasson (A.E.I. Research Laboratory).

Metallurgical Applications of Electron Probe Micro-Analysis

Dr. V. D. Scott first described the principle of this non-destructive technique, in which a metallographically prepared metal surface is irradiated by a focused beam of high-energy electrons. He said that the characteristic X-rays emitted from elements contained within the irradiated volume were analysed, and the elements present thus identified and estimated quantitatively. The comparatively high resolution of the finely focused electron beam (~1 μ dia.) made the instrument ideally suited for studying highly localized changes in concentration (sensitivity $\sim 10^{-14}$ g). Theoretically, the principle could be extended to analysing for all elements, but in practice X-rays characteristic of lighter elements ($Z < 11$) were soft and in consequence were either difficult to detect or not detectable at all, owing to their absorption in the media surrounding the counter.

After discussing briefly Castaing's original apparatus and the work of Mulvey and of Cosslett and Duncomb, Dr. Scott described the Cambridge scanning micro-analyser operating in the Metals Division, A.W.R.E. In this instrument electrons scattered from the specimen surface were collected to form an image of the scanned area on an oscilloscope synchronized with the electron probe. Inspection of areas up to 400 μ^2 could thus be carried out, and small regions quickly located for more detailed examination. The emitted X-rays were investigated by crystal-spectrometer and pulse-analysis methods, and by " tuning-in " to X-rays from a selected element a scanning X-ray image was displayed on a second synchronized oscilloscope.

A simple example of the type of information given by the micro-analyser was illustrated by means of a specimen consisting of a multi-sandwich of alternate layers of copper and nickel of decreasing thicknesses from 5 to $\frac{1}{2}$ μ.

The diversity of metallurgical problems to which micro-probe analysis had been applied included diffusion, selective oxidation during scaling, segregation, inclusion analysis, and phase determinations. Some illustrations were presented to demonstrate the unique facilities offered by this technique.

It was stressed that although qualitative and semi-quantitative information of the type shown above could be quickly and easily obtained, quantitative work was in many cases more complicated. Inaccuracies arose from X-ray absorption and X-ray fluorescence effects, but these could be minimized by using standards of known composition, preferably close to that of the sample. Further analytical errors could be caused by surface irregularities which intercepted the emitted X-rays on their way to the collector, and by the generation of X-rays from sub-surface features not visible optically.

Dr. Scott concluded by saying that ahead of the micro-probe analyst lay a great deal of important and interesting work, both in improving the analytical technique itself and in its application. For example, an obvious need for improvement concerned the detection of soft X-rays, in which range were included elements of particular interest to the metallurgist, carbon, nitrogen, and oxygen, and to satisfy this demand the use of new-pulse analysis techniques, and various X-ray monochromators and detectors was being investigated. For the metallurgist interested in its application, a major concern would be the establishment of accurate quantitative data.

The Theory of Electron-Probe Micro-Analysis

Mr. N. Swindells said that quantitative analysis by the electron-probe micro-analyser depended on the fact that, when the probe excited the X-radiation of elements in the target, the mass concentration of an element was proportional to the intensity of its characteristic emission line. In practice the mass concentration was determined by comparing the intensity from a given element in the unknown specimen with the intensity obtained from a pure sample of the same element. The proportionality relationship was valid to a close approximation in many cases. When, however, the specimen and the pure standard did not have similar properties with respect to electrons or X-rays, or when radiation from one element in the target excited fluorescent radiation from another element, then the simple relationship did not hold and corrections became necessary.

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Most of the theory which underlay the application of corrections was based on work of Castaing published in 1952. Since then more instruments had come into use, and as more investigations had been made it had emerged that the knowledge and data required to make accurate corrections were uncertain and scarce.

Corrections to the measured intensity to account for self-absorption and the presence of fluorescent X-radiation required a knowledge of the distribution of excitation with depth in the target. Castaing's experimental approach for obtaining the distribution function $[\phi(\rho z)]$ was outlined, and the results which he obtained for copper, aluminium, and gold were shown. The curves of $\log \phi(\rho z)$ did not start from zero and first increased with increase of depth. The value of $\phi(\rho z)$ at zero depth depended on the back scattering of electrons, the value increasing with the atomic number. The electrons described varying trajectories in the target and some might pass back through regions which had already been ionized and still had enough energy to cause further ionization. This would explain the initial increase of the function with increasing depth.

The correction for self-absorption could be obtained in two ways. Castaing had shown that I/I_0 (I = observed intensity, I_0 = intensity with no absorption) was a function $f(\mu \operatorname{cosec} \theta)$, where μ was the mass-absorption coefficient and θ the angle at which the X-ray beam emerged from the surface. He had also shown that the same curve was the Laplace transformation of the distribution function $\phi(\rho z)$. So to obtain the correction curve experimentally the intensity was measured as a function of $\mu \operatorname{cosec} \theta$ as the surface angle changed. Extrapolation to $\mu \operatorname{cosec} \theta = 0$ (which is physically inaccessible) gave the value for I_0. A plot of $\log I/I_0$ as a function of $\mu \operatorname{cosec} \theta$ constituted the correction curve for the accelerating voltage used. The same curve was also obtained by performing the Laplace transformation of the distribution function. The curve obtained for an arbitrary target could be used for all targets to a close approximation. The curve could be generalized to cover all targets to a closer approximation by using a weighting factor in the argument of $\mu \operatorname{cosec} \theta$, which accounted for the effect of atomic number.

Not many such curves had been published, and so their usefulness at present was restricted to favourable circumstances with binary-alloy targets. The values of μ were not known with any precision, and the absorption coefficients for L radiations were not known at all. Nevertheless, corrections for absorption could be made with sufficient accuracy in most cases.

Finally, the circumstances in which the observed intensity could include some radiation due to fluorescence were outlined. In particular, Castaing's estimate of the amount of fluorescent radiation due to excitation by the continuous background was discussed. It was pointed out that this might be of considerable importance in the analysis of small precipitates, especially when the matrix consisted entirely of the element being analysed in the precipitate.

Electron-Beam Melting

Mr. D. B. Gasson said that the use of electron bombardment as a method of heating in metallurgy was an established laboratory technique, and that in many respects it had now reached the stage of industrial importance.

Bulk melting to refine and recrystallize refractory metals and oxides and a range of chemically reactive materials could be carried out by using relatively simple electron-bombardment assemblies; but for welding and machining, an electron gun capable of forming a high-energy beam, focused on to a small area of the specimen, was necessary.

With the simple layout that could be used for the floating-zone melting of material in rod form, accelerating voltages of 2–10 kV were used and a bombardment power of a few hundred watts, whereas voltages from 10 to 150 kV were necessary to give an increasingly well-defined electron beam.

The electron-beam method was very versatile; thus, if the gun incorporated a beam-deflecting system, a large specimen could be heated uniformly by scanning the beam over the surface at high speed; by holding the beam stationary, a small selected region could be melted, as was required when welding, or evaporated, as when machining.

When heating material with gaseous inclusions which would raise the gas pressure in the work chamber when released, it was essential to protect the electron guns against electrical breakdown. This was effected by containing the guns in a separately evacuated manifold in which the pressure could be maintained at $<10^{-3}$ mm Hg, connection to the work chamber being made via apertures just large enough to allow the electron beams to pass through.

On the industrial side, refractory metals could be melted and cast into large rods, for which bombardment powers >200 kW were used. A big advantage of this method of heating was its high efficiency, since the heating energy could be directed on to the surface to be heated, thus making the method, economically, very attractive for large-scale operation.

APPOINTMENTS VACANT

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